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The East Helena Plant of the American Smelting and Refining Company

Raymond W. White

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Report on
THE EAST HELENA PLANT OF THE AMERICAN
SMELTING AND REFINING COMPANY

Submitted as fulfillment of
Metallurgy 69
Montana School of Mines

By
Raymond W. White

Butte, Montana
October 18, 1957

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SMELTING AND REFINING COMPANY

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Butte, Montana
October 18, 1957

1806 South Franklin Street
Butte, Montana
October 18, 1957

Dr. C. W. Haynes
Department of Metallurgy
Montana School of Mines
Butte, Montana

Dear Dr. Haynes:

In compliance with the course requirements of Metallurgy 69, I herewith submit a report on the operations of the East Helena Plant of the American Smelting and Refining Company, where I was employed during the summer of 1957.

As blast furnace lead smelting is an old process, about which a great deal has been written, I have tried to emphasize the more recent changes and developments in carrying out the process, rather than to repeat the established theory and methods involved.

While the East Helena plant's primary purpose is the production of lead bullion, there is also an active interest in improving the efficiency of the process.

Respectfully submitted,

Raymond W. White
Raymond W. White

TABLE OF CONTENTS

I. Letter of Transmittal	ii
II. Abstract	v
III. Introduction	1
A. Functions of the East Helena Smelter	1
B. Improvements of Smelting Methods	2
IV. Smelting Operations	4
A. Incoming Material	4
B. Sinter Plant	7
C. Preparation of Blast Furnace Charge	14
D. Blast Furnace	20
E. Dross Plant	27
V. Plant Management	29
A. Supervision	29
B. Engineering Office	29
C. Safety Program	30
VI. Conclusion	34

LIST OF FIGURES

Figure	Page
1. General Flow Diagram, American Smelting & Refining Co., East Helena Plant	3
2. Sample Mill, East Helena Smelter	6
3. Sinter Plant, East Helena Smelter	9
4. Cottrell Dust Removal System	12
5. Blast Furnace Charging System Flow Sheet	15
6. Continuous Tapping Bay	23
7. Proposed Lead Tapping System	25
8. East Helena Plant Safety Organization	33

ABSTRACT

The East Helena plant of the American Smelting and Refining Company is a custom lead smelter. The chief product of the smelter is lead bullion, although by-products such as matte, speiss, cadmium-rich fumes, and zinc-rich slag are also produced. While the smelter is old, many of the methods used are new, some of which have been developed at the plant.

Among the most important methods developed at the plant are 1) the continuous tapping of lead and slag from the blast furnace and continuous tapping of slag from the first settler; 2) proposed continuous tapping of lead; 3) proposed method of blast furnace charge preparation; and 4) the emphasis on safety and the outstanding safety record compiled at the plant.

THE EAST HELENA PLANT OF THE AMERICAN
SMELTING AND REFINING COMPANY

INTRODUCTION

The East Helena plant was built about 1880. Even then, the process for the production of lead by the reduction of lead oxide with coke in a blast furnace had been established. While the principles of the process are well established, and there has been little recent further development of theory, means of carrying out the process more efficiently have continuously been developed, which have resulted in finer products, lower operating costs, and less manual labor. In this report, discussion of basic principles of the process have been held to a minimum, while recent improvements in methods have been emphasized.

OPERATIONS OF THE EAST HELENA PLANT

The East Helena plant is primarily a custom lead smelter. Materials smelted at the plant include lead concentrates, lead ores, lead-rich residues, and by-products from other smelters.

Products produced at the smelter consist mainly of lead bullion, although other metals, such as copper, are retained as matte and speiss and are shipped to other smelters. A large amount of zinc, in zinc-rich slag, is sold to the Anaconda Company.

The main operations of the smelter include crushing and sampling of ores, concentrates, and residues; sintering lead-bearing minerals and fluxes to form an oxide blast furnace feed; smelting of the sinter to produce lead bullion; drossing of the bullion; and resmelting of the dross.

IMPROVEMENTS IN SMELTING METHODS AT THE EAST HELENA PLANT

Among the recent developments in lead blast-furnace smelting, development of the continuous tapping process at the East Helena plant is probably one of the most important, because of the large saving in labor and the improvement of efficiency.

Another potentially important method being developed is the use of the pelletizing disc for the preparation of feed for the sinter machines. Also of importance, although only indirectly related to the actual process, is the safety record of the East Helena plant. While part of the improvement in safety is an outgrowth of improved equipment and methods of operation, much credit must be given to the plant management for the aggressive safety program in use at the plant.

SMELTING OPERATIONS

Smelting is the fusion of a rich ore or concentrate to obtain a crude metal or a fused sulfide (matte). Lead is the principle product of the East Helena smelter. Matte, slag, and speiss containing other metals are shipped to other smelters.

INCOMING MATERIAL

At the East Helena plant, the material to be smelted consists of lead concentrates, lead ore, dross, lead-rich residues, dust, and by-products. In addition to these materials, large quantities of coke, lime, silica, and scrap iron are needed. Of these materials, coke is used for heat and as a reducing agent, while lime, silica, and scrap iron are used for fluxes.

The materials come from many sources throughout the world. Lead concentrates are shipped from Canada, South America, and Australia, as well as from the Coeur d'Alene district in Idaho and other A.S. & R. properties in the United States. Residues come primarily from the Anaconda Company's zinc plants at Anaconda and Great Falls, Montana. Some of the dust and other by-products are recovered from the East Helena plant. Other materials, such as siliceous ore, silica, pyrite, and limestone, are obtained from nearby sources. A large part of the coke is shipped from Fernie, British Columbia, and the coke breeze used is screened at Victor Chemical Plant near Butte and the Carter Oil Company at Billings.

Most of the materials arriving at the East Helena plant come by rail. Some concentrates and dross, mostly from Australia, arrive in sacks. Sacks are loaded into railroad cars and dumped by hand. The sacks are later burned to recover the entrained concentrates. A small amount of material, mostly local ore, arrives by truck. This material is dumped into railroad cars and handled in the same manner as the rail shipments.

The concentrates, residues, dust, dross, and by-products, as well as coke and fluxes, which do not require crushing, are pipe-sampled and dumped directly into storage bins. The siliceous ores, which are used for flux, as well as to recover the mineral content, require crushing. The crushing and sampling of the ore is done in the sample mill.

As shown in Fig. 2, the ores are dumped from railroad cars into a large hopper. The ore is taken by conveyer across a two inch grizzly into a primary crusher, where the larger pieces of ore are crushed to 2 in. maximum size. The ore is then carried by conveyer to a vibrating screen, which separates the particles into three separate sizes, $+ 3/4$, $- 3/4 + 3/8$, and $- 3/8$ in. The largest size, $+ 3/4$ in., is passed through a gyratory crusher and returned to the vibrating screen. The second size, $- 3/4 + 3/8$ in., is passed through a set of rolls and returned to the vibrating screen on the same conveyer as the crushed larger size. This arrangement forms a closed circuit in which the incoming ore is reduced in size to $- 3/8$ in.

As the crushed material leaves the vibrating screen, it passes over three Vezin samplers set in series. The first sampler catches one-fifth of the total ore. The second sampler catches one-fifth of the material caught by the first sampler, or $1/25$ of the total ore. The material passes through another set of rolls and to the third sampler, which again catches one-fifth of the material, or $1/125$ of the total. The retained material is loaded into a railroad car and dumped into a storage bin, and the sample is taken to the sample-preparation room.

Samples from the Vezin samplers are further mixed by dumping from one dump-bucket to another several times. After the sample material has been thoroughly mixed, it is reduced to about 15 lb by dumping through a Jones splitter. The sample is dried for 24 hours and pulverized to from

Sample Mill, East Helena Smelter

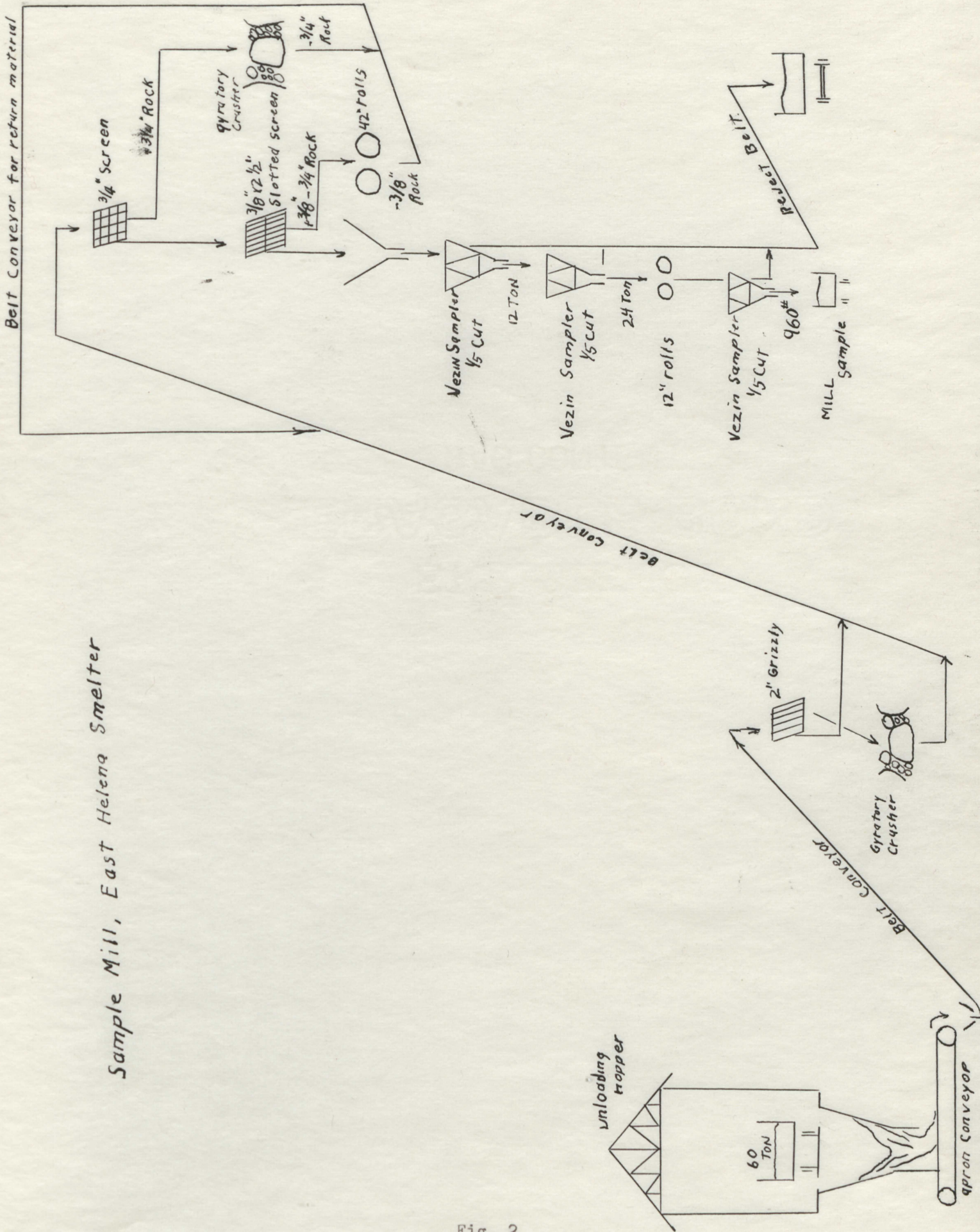


Fig. 2

- 100 to - 200 mesh, depending on grade and "spottiness". The pulverized material is mixed in a cube mixer and divided again with a small Jones splitter. Small samples of this material are sent to the laboratory for analysis.

The pipe samples of the concentrates and residues are treated similarly. Materials are sampled in 4-car units of 240 tons.

All ores, concentrates, and residues which are high in silver or gold are treated in a separate room to prevent contamination of the low grade material. A small amount of high grade material could raise the assay of the low grade material considerably.

SINTER PLANT

Railroad cars of ores, concentrates, residues, coke breeze, and fluxes are dumped from a highline into large storage bins. Materials from the bins are loaded into feed hoppers by an electric crane. Short conveyers, which travel at a constant rate, carry the material under a water spray and dump the materials in layers on two longer conveyers. The rate of feed from the hoppers is controlled by adjusting the level of the hopper gates. The material on the two conveyers passes under mechanical rag pickers, which remove any bags in the material, and dumps onto one main conveyor belt, which carries the material under an electro-magnet to remove tramp iron and thence to a hammer mill. The hammer mill breaks up lumps, mixes the material, and, to a certain degree, reduces the particle size.

At the present time, the material passes by conveyor belt to a pelletizing drum. The drum, which is a rotating hollow steel cylinder about 5 ft in diameter by 20 ft long, moistens and rolls the material into pellets suitable for sintering.

While the pelletizing drum is more effective than previous methods used, many of the pellets formed are about 1 in. in diameter, and others are as small as 1/16 in. The unequal-sized particles do not make good feed for the sintering machines. The large particles cannot be sintered in a short enough time, because of the time required for the oxygen to diffuse through the particle and to react with the sulfur and carbon. Satisfactory sintering of the present material accordingly requires a second sintering. This is uneconomical, because of the added cost of coke and handling of the sinter.

In order to eliminate the added cost of double sintering, the sinter circuit is being revised to include a pug mill and pelletizing disc. In the proposed circuit, the existing pelletizing drum will be used only for mixing. There will be no moisture added to the material, so that the material leaving the drum will be, except for being better mixed, in the same condition as when it arrived at the drum.

The material, after leaving the drum, will enter a pug mill, which is a moistening chamber. The moistened material next enters the pelletizing disc. This machine is essentially a large, flat rotating disc set at an angle of from 45 to 60° with the horizontal. The disc has a 15 in. flange perpendicular to the flat disc. After the material has been rolled into pellets, the pellets drop over the edge of the flange onto a conveyer, and into the sinter hoppers. It is believed at the East Helena plant that the pelletizing disc will produce a uniform product of 1/8 in. to 3/16 in. Using the more uniform feed, it is believed that sufficient sulfur can be removed with one pass, and that a considerable economy in coke breeze will be effected.

Sinter Plant, East Helena Smelter

Fig. 3

The pelletizing disc, designed and built at the East Helena plant, is not a new idea. In principle, it is similar to nodulizing machines used in the steel industry. However, the products designed in the two industries differ, so that this machine, instead of producing a hard pellet about $\frac{1}{2}$ in. or larger in diameter, should produce a smaller pellet only hard enough to hold together until it reaches the sinter machine. If the pellets were too hard, the hardness would tend to slow down the burning of the coke and sulfur due to the greater resistance to oxygen diffusion within the pellet.

Single pass sintering has been achieved by the Bunker Hill and Sullivan Company, but at great expense. If the method being employed at East Helena is successful, it could have a considerable effect on all blast furnace charge preparation.

Feed for the sinter machine, at the present time, consists of pelletized new material and some sinter which is rerun. The return sinter is added for better air passage through the forming sinter cake. Also, the addition of sinter dilutes the total sulfur present, which gives a better product and allows more rapid sintering. Return material is added only on the first sinter.

With the present arrangement, the new material to be sintered leaves the pelletizing drum, and travels by conveyer to the first sinter machine hoppers. Return sinter is added on the conveyer. The conveyer is discharged by a tripper belt so that it may be moved from one hopper to the next. Sinter leaving the first-over machines is taken by conveyer through a screw crusher and a set of rolls. Next, it is raised in an elevator, passed through a pug mill for moistening, and split. Part of the sintered material goes to a surge tank, from which it is returned as return material to the first sinter circuit. The remaining material is taken by conveyer

to the second-pass sinter machine hoppers. After the second sintering, the material is taken by conveyer to a storage bin ready for smelting in the blast furnace.

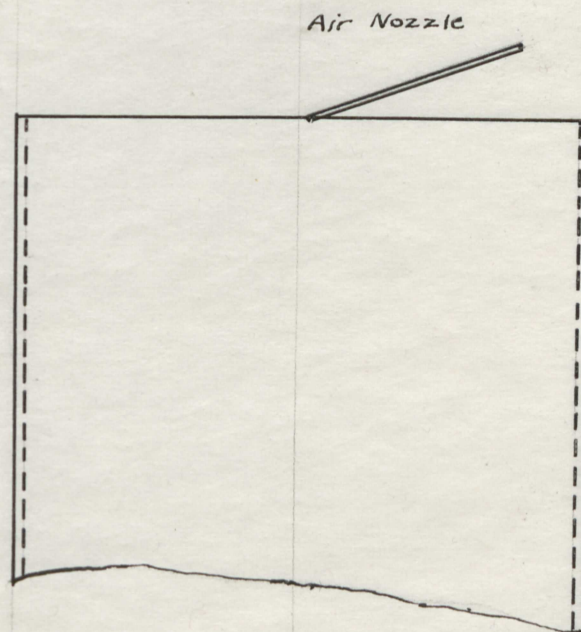
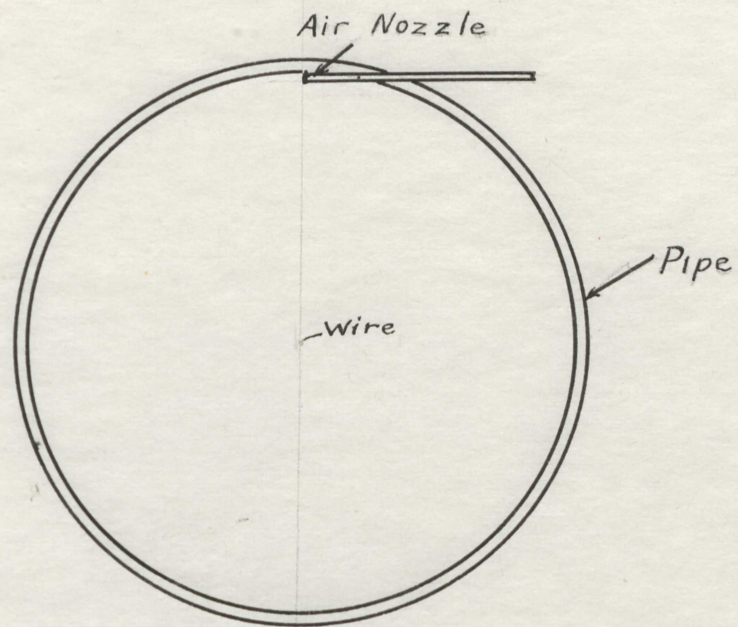
It is felt at the plant that under the newly proposed system, it will be necessary to rerun a portion of the sinter in the same manner in which it is currently handled; that is, by crushing, moistening, and mixing with new material. In this case, the material to be rerun will follow the existing return circuit, while the remainder of the material will go to the storage bin. As this circuit is rather an experiment, the exact amount of material per machine cannot be determined, and probably some change in the amount of material rerun, the depth of the bed, the speed of travel, and the amount of coke used will be necessary.

The existing circuit will remain intact and ready for use in the event the new system does not operate as expected. Success of the new system will probably increase the capacity of the sinter plant. At present, this is no great advantage, because the sinter plant as operated is more than adequate for available ores.

The dust-laden gases leaving the sinter machines are cleaned to remove the dust and allowed to escape into the atmosphere. It is necessary to remove the dust to prevent contamination of the air, as well as to recover the valuable minerals in the dust.

A spray chamber conditions the dust for removal. The gases are passed through a pipe-type Cottrell precipitator, which removes the dust electrically. During the month of June, 316 tons of material were recovered at the Cottrell, and 8 tons lost, for an efficiency of 97.5 per cent.

The spray chamber is simply a portion of the flue which has a series of high pressure water jets set in the top of the flue. Water is pumped



Cottrell Dust Removal System
Fig. 4

through the jets at 300 psi and allowed to flow from the flue into a settling pond through an opening in the bottom of the flue. The water removes a part of the dust and moistens the gas, improving its electrical conductivity. The relative humidity of the gases should be from 49 to 50 per cent for the best results. The humidity may be closely controlled by the amount of washing done in the spray chamber.

The moistened gases enter the Cottrell system through the bottom of the pipes and pass upward. The dust is removed in the pipes. The gases pass from the pipes, are collected, and pass to the stack and on to the atmosphere.

Formerly, the dust was removed from the pipe by a mechanical "knocking" system. Figure-eight shaped pieces of cast iron were suspended on levers attached to a shaft, which passed to the outside of the cleaning compartments. The shaft was then rotated by a lever, which swung the cast iron knockers against the pipe, jarring the dust loose and allowing it to fall into dust bins below. This system was replaced in the spring of 1957 by a high-pressure air cleaning system. The new system consists of air jets 0.120 in. in diameter set above the top of the pipe, and tangent to the inside of the pipe at an angle of 15°. Air from the jets, at 80 psi, spirals down the pipe and effectively forces the dust into the bins. This system is semi-automatic. That is, a push button closes the dampers in the compartment to be cleaned; another push button operates an electric valve, which turns on the air. After blowing, the air is turned off, and, after a short time to allow the dust to settle, the dampers are opened. This system has been in operation for only two months, but it is reportedly very efficient.

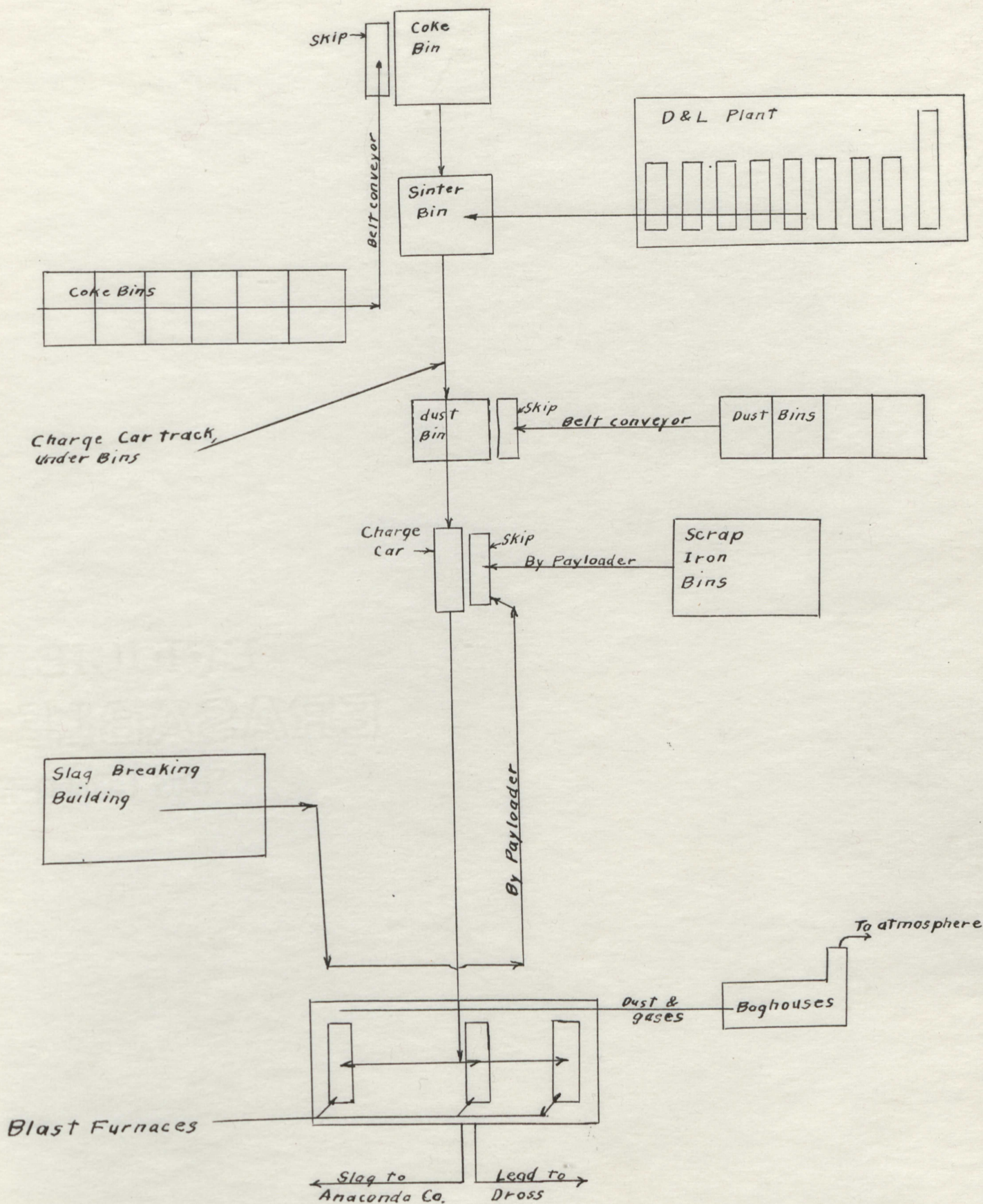
The working mechanism of the Cottrell consists of ten units, each containing 180 six in. pipes, 12 ft long. There are two units to each compartment. A wire passes through the center of each pipe. Some of the wires are held in place by weights, while others are held in place by springs. The springs are more efficient.

An electric current of 0.2 amps at 34,000 v is maintained through the wires. The high voltage ionizes the particles and attracts them to the pipe and to the wire, from which they are blown into the dust bins. The dust is burned and removed monthly.

During the annual dust cleanup, repairs are made and corroded pipes are replaced. This year, 30 pipes had large corrosion holes and had to be replaced. More serious than these leaks were several large holes in the floor, where the steel had been eaten away. This allowed gases to pass through the Cottrell plant without passing through the dust-removing pipes. This is probably the cause of poorer efficiency during the last several months. Some tests with aluminum alloys are being made in an attempt to reduce corrosion.

PREPARATION OF BLAST FURNACE CHARGE

In most pyrometallurgical operations, slag compositions are of prime importance. Slag from lead smelting is no exception. Proper slag composition is necessary to eliminate waste materials while retaining a minimum amount of the desired metal. Accordingly, the slag must have a relatively low melting point, low viscosity, and low specific gravity. A slag containing about 23 per cent silicon dioxide and 22 per cent to 23 per cent calcium oxide is the most satisfactory. The remainder of the slag is generally iron oxide; however, as zinc oxide in slag acts in the same manner as ferrous oxide, much of the nominal iron in the slag may be re-



BLAST FURNACE CHARGING SYSTEM
FLOW SHEET

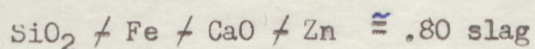
placed by zinc. The zinc content of the slag is usually about 15 per cent. The chemical composition of the slag is $2 \text{ SiO}_2 : (\text{FeO}, \text{ZnO}) : 2 \text{ CaO} : 2 \text{ CaO}$. Slag of this proportion tends to hold formation of zinc ferrite ($\text{ZnO} \cdot \text{Fe}_2\text{O}_3$) to a minimum. The prevention of zinc ferrite is desirable, because this compound tends to entrap metallic lead, which increases lead losses in the slag.

Most of the materials entering the blast furnace are first combined into a sinter. There are two reasons for sintering; 1) the elimination of sulfur by converting sulfides to oxides, and 2) the formation of a coarser product, which is a more suitable blast furnace feed.

The sinter charge is composed of lead concentrate, ores, residues, limestone, some by-products, and coke breeze. While the burning of sulfides to oxides produces heat, it is necessary to maintain a temperature of about 600°C . Coke breeze is necessary to maintain this temperature and allow the sulfur to burn to less than 1 per cent of the charge.

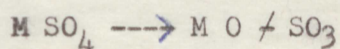
On the following page is a sample calculation, which shows how the charge calculations are made. The amounts of the various components are changed as their analyses change. The method used is trial and error; however, with experience, adjustments can be made in the charge design with little difficulty.

The factors used in calculating "shrinkage" are based on chemical considerations below, while the factor used for calculating the amount of slag is based on experience and previous slag analyses.



Factors for:

Residues: (assuming all sulfur as sulfate and all sulfur removed.)



As 80 lb weights of SO_3 are given up for each 32 lb of

[illegible]

water	body
-------	------

93,22	76ms
-------	------

	.15
--	-----

 $0.75 \times 12 =$

pyrite —

97-146

4,91	= 2
------	-----

	-0.5	x
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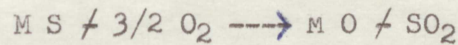
conc

Charge Typical Charge Calculation

-18-

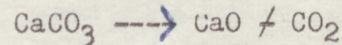
sulfur, the weight loss from the residues must be $80/32$ of the sulfur content of the residue, or $2.5 \times$ sulfur content of the residues.

In a similar manner, assuming sulfur in concentration as sulfide sulfur:



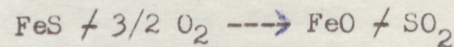
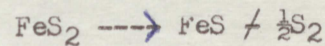
In this case, 16 lb of oxygen replaces 32 lb of sulfur, or $\frac{32 - 16}{32} = .5$

The factor for lime is:



as 100 lb of CaO will lose 44 lb of CO₂. In this case, the factor has been rounded off to .4, probably because not all of the CaCO₃ is calcined in the sinter machine.

Sulfur in the silica and siliceous ore is considered as pyrite.



In this case, the first sulfur atom is lost by decomposition. The second sulfur atom is replaced by an oxygen atom, so the weight loss becomes $\frac{64 - 16}{64} = .75$

The actual charge dumped into the blast furnace consists mainly of sinter, coke, and scrap iron; although other materials are added such as dust, settler slag, and cleanup material. The by-products which are added directly contain lead and zinc oxides and sulfates, as well as unburned coke dust. As there is little lime or silica in these materials, they have little effect on slag composition. The scrap iron added burns to

iron oxides and helps to supply heat in the blast at the lower levels where it is needed, as well as to help form a desirable slag. The coke is added both for heat and to act as a reducing agent.

Materials used during June consisted of the following:

Total unit charge - 23,000 tons

	<u>%</u>	<u>tons</u>
Sinter	92.16	21,200
Dust	4.63	1,068
Foul slag	.83	191
Sinter conveyor cleanup material	.70	161
Lead recovered from windbox	1.68	380
	<u>100.00</u>	<u>23,000</u>

Coke on charge 10.0 (FC = 83.3%) 2,320

F.C. on charge 8.4 1,930

Scrap iron on charge 1.2 276

The charge is made up in a charge car, and consists of about 6 tons per car. The coke (currently 1140 lb) is automatically weighed and dumped into the car. Next, the sinter (currently 10,000 lb) is automatically weighed and loaded through three vibrating feeders. These products are weighed to the nearest 5 lb. The charge car is then moved by a motor to a skip, into which the dust and scrap are loaded. The skip rests on a scale and is dumped into the charge car. When the desired weight has been reached, the car is then pulled to the top of the blast furnace by a hoist and dumped. A dust bin and conveyer system is under construction, so that the dust will also be automatically loaded.

BLAST FURNACE

The blast furnace currently in use at the East Helena plant is about three years old, and has been in continuous operation for more than one

year. A new furnace was completed in September, 1957, but has not yet been put into operation. The new furnace differs in design from the older furnace in several ways, although the general design and capacity are the same. The main differences are in the 1) slope of the sides, 2) water jackets, 3) feed arrangement, and 4) crucible.

The new furnace has straight ends, while the ends of the older furnace sloped outward from the top to the bottom. This change was made mostly to simplify maintenance, and because there seemed to be no great advantage in the shorter top. The second change, the extension of the water jackets to include the upper part of the furnace, eliminates the brickwork in the upper part of the furnace, again reducing maintenance. The third change is the addition of a "thimble". The thimble is an open-bottomed box which collects the flue gases, delivers them to the down-take pipe, and allows feed to be dumped on either side. This arrangement has been used in the iron blast furnace for some time and has been used previously in the lead blast furnace. The last change, the elimination of the crucible, has been a direct result of the tapping process developed at the plant, which will be discussed later. The necessity of a crucible with the new process has been eliminated. In fact, the crucible in the operating furnace has long ago filled with solidified lead and slag.

The new furnace will be used while the older one is repaired, and probably until repairs are needed on the new one. At present, no plans have been made to operate two furnaces.

A continuous tapping process has been developed at the East Helena plant. The most outstanding feature of this process is its simplicity. Molten slag and lead pour continuously from the furnace into a large

settler. The lead settles to the bottom, while the lighter slag overflows into a second settler, where any remaining lead settles out. The slag flows continuously into 5 ton slag cars, which, when full, are taken directly to the Anaconda Company's nearby zinc fuming furnaces.

At the present time, the lead is allowed to accumulate in the first settler and tapped periodically. The second settler is placed in the circuit to recover any lead which escapes the first settler. Freezing of the surface of the slag and lead discharging from the furnace is prevented by a gas burner. A similar burner is located between the first and second settler. Because lead in the bottom of the settlers gradually freezes from the bottom, the settlers have to be changed periodically. The larger first settler is changed every 1 to 2 weeks, and the second settler every 3 days. The sculls are crushed and added directly to the blast charge.

The tapping bay, which carries the slag and lead from the furnace to the settler, may be seen in Fig. 5. While the continuous tapping bay is simple, both in principle and mechanical operation, it is the first successful continuous tapping system applied to a lead blast furnace. Continuous tapping of iron blast furnaces has long ago been achieved. Several advantages of the continuous tapping process are 1) less manpower required, because there is no necessity of opening tap holes; 2) a better, more pure product; 3) less lead loss in slag, because the separation of slag from lead appears to be more complete than when the operation took place in the furnace; and 4) less freezing of the tuyeres.

The level of the slag remains approximately constant below the tuyeres. Formerly, the slag level would approach the tuyeres before the slag was

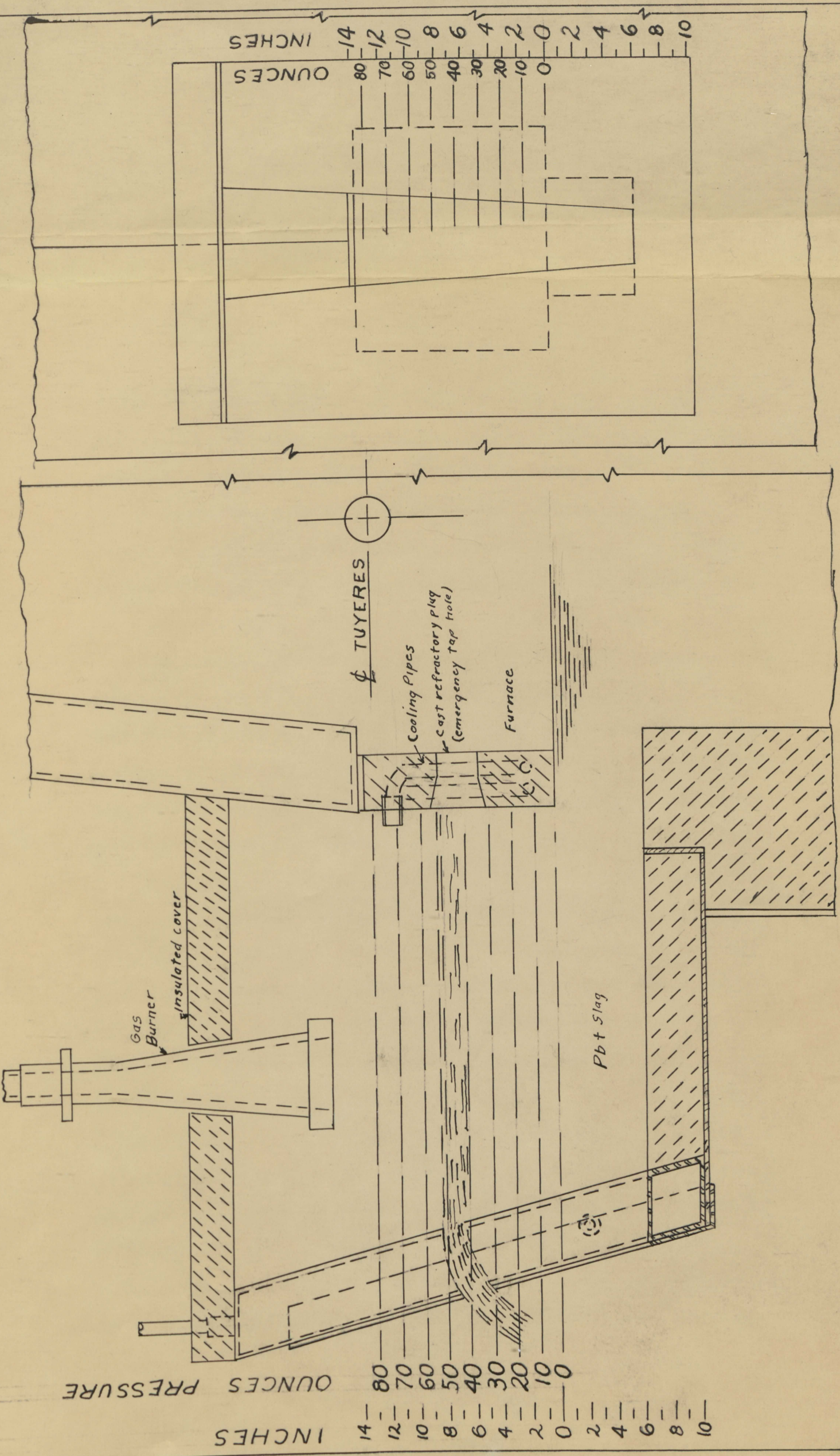


Fig. 6

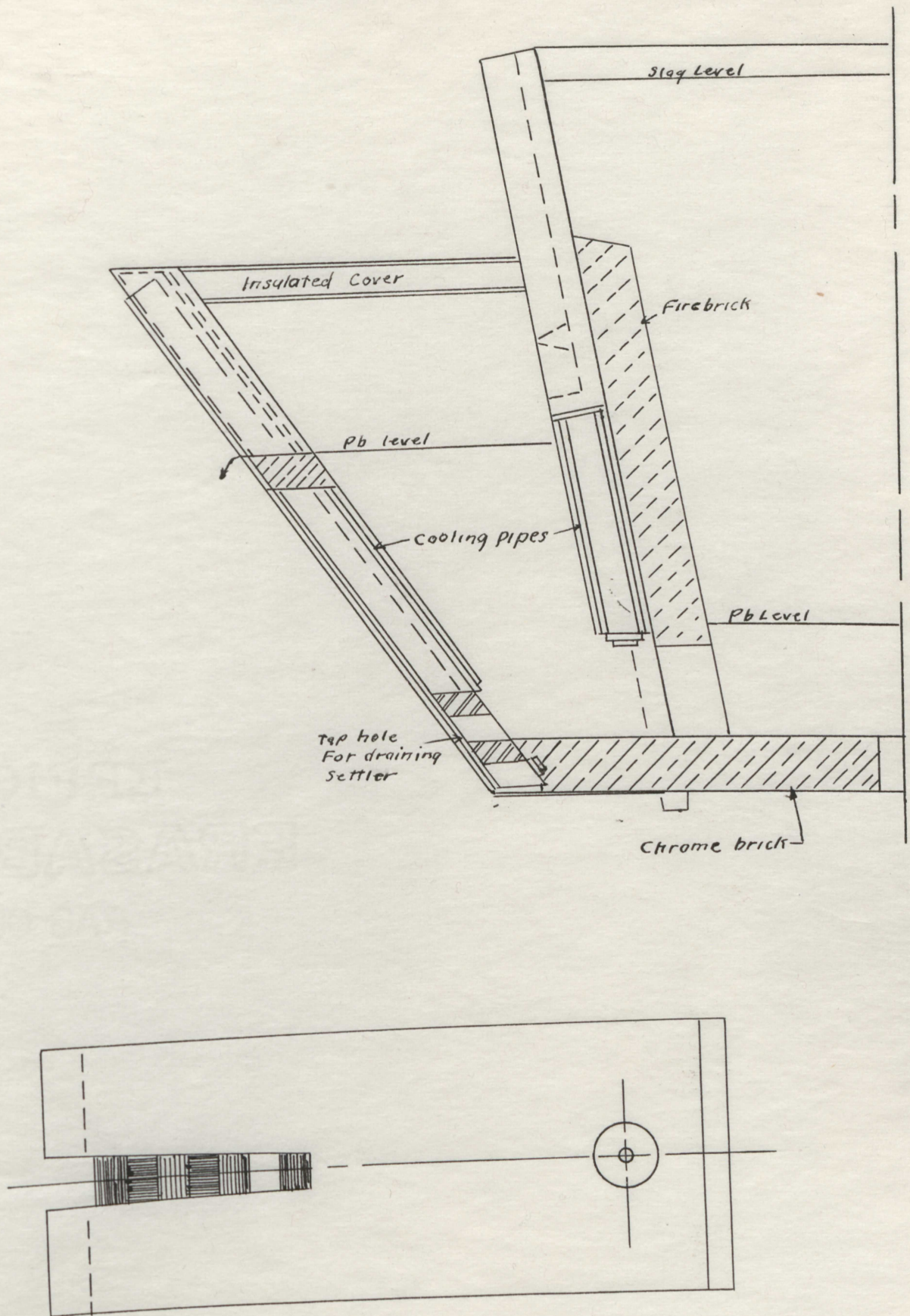
tapped. An error in judgment of the height of the slag would result in slag running into, and freezing in, the tuyeres. This process is being patented by the American Smelting and Refining Company.

The tapping process is being further developed, and, in the near future, the lead will be continuously tapped from the first settler, also, and the second settler will probably be eliminated. The proposed system for continuous tapping of lead from the first settler is shown in Fig. 6.

This system is simply an overflow of lead from a lead bay which opens into the first settler. It is based on the difference in weight between lead and slag. As lead is approximately three times heavier than slag, a column of lead one foot high will support a column of slag three feet high, provided the slag is held on one side; i. e., it is not allowed to pass into the lead compartment.

Mixed slag and lead pour from the furnace into the first settler, where the lead settles to the bottom by gravity. As long as the lead level is above the top of the connecting hole, slag cannot run into the lead bay, but builds up a column of slag which will balance the shorter column of lead. As the overflow of the first settler is fixed, the lead level of the bay can be adjusted to cause both to overflow when the lead in the settler has reached a predetermined height. It is necessary to have a lead seal in order to keep slag in the settler, but it is also desirable to maintain the lead as low as safety permits to allow a greater retention time for the slag; hence more complete separation of the slag and lead.

Lead ores frequently contain arsenic and antimony. If the concentration of these elements is low, little speiss is formed and does not



Proposed Lead Tapping System

Fig. 7

constitute a problem; however, with ores containing larger amounts of arsenic and antimony, speiss is formed, which could present a serious problem, for two reasons. The first is that speiss is highly corrosive to the steel settler. This problem can be solved by using a refractory lining over the area in which the speiss would accumulate. The second problem is the means of tapping the speiss from the settler.

Speiss is lighter than lead, but heavier than slag, and will form a layer between the slag and lead. If the speiss accumulated to a sufficient depth, the added weight would force the lead in the settler to a lower level. If this change was great enough, the speiss would flow into the lead bay and contaminate the lead. This could be overcome by raising the level of the lead overflow, in which case, the speiss would remain in the settler, and eventually fill and flow out with the slag. As speiss is valuable, it becomes necessary, then, to develop a method to remove speiss.

Although speiss removal through a separate tap hole was suggested as a means of eliminating speiss, it was rejected, because the addition of speiss car handling facilities would have been necessary; e.g., tracks for speiss car to tap hole. An alternate suggestion was made as a means of tapping speiss, which would involve no additional facilities. This method consists of lowering the lead overflow to a point where speiss could flow into the lead bay, and could be made to overflow into a speiss car on the lead car tracks. As the speiss is removed, the lead level in the settler would again raise to near its former level, and by raising the overflow of the lead bay, the seal would once more be established, and the lead could be tapped as before. This operation, while it would give

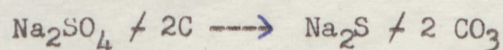
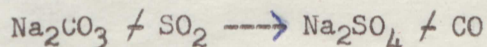
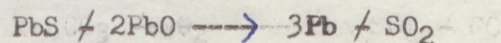
an impure speiss, would involve no additional initial expense. The lead in the speiss would be recovered in the dross smelting operation.

DROSS PLANT

Bullion from the blast furnace is taken in 5 ton lead pots to the drossing plant, where it is dumped by crane into a drossing kettle. About 200 lb of Na_2CO_3 is stirred into the hot liquid lead, and the mixture is cooled. The cooling decreases the solubility of impurities in the lead, and forces them to float on the top, where the dross is skimmed off. The lead is reheated and pumped into a casting kettle, where 150 lb of sulfur is added to form Cu_2S from copper in the lead. The copper sulfide rises and is skimmed off. The lead is then pumped into 10 ton casting molds and the castings are shipped to the refinery. The dross is saved until a sufficient quantity has accumulated to operate the reverberatory furnace for from three to six weeks.

The use of soda in the drossing operation makes it possible to operate the reverberatory furnace at lower temperature than would be possible using a ferro-calcic silicate slag. The lower temperature results in less copper dissolved in the lead and less dissolved lead in the matte-speiss, which is desirable.

The principle chemical reactions involved in the process are as follows:



Sodium sulfide collects the iron in the matte and speiss, and, as there is no silicon or lime present, no slag is formed.

The dross, as well as other by-products, such as dust, are then smelted in a small reverbatory furnace, where lead bullion, soda speiss, and soda matte are formed. The bullion goes to the drossing kettles, along with the blast furnace bullion. The speiss is granulated, sampled, and shipped to A.S. & R.'s Tacoma smelter. The soda matte is crushed and sampled, and also shipped to the Tacoma smelter. Gases from the reverbatory furnace join with the gases from the blast furnace and pass through the bag houses into the atmosphere.

PLANT MANAGEMENT

The American Smelting and Refining Company is a large corporation. As the East Helena smelter is only one of its many operations in the mineral industry, overall management, company policy, and co-ordination of the smelter's activities are controlled by the company's main offices in New York. On the local level, the responsibility of the smelter is in the hands of the manager, Mr. Joseph T. Roy.

SUPERVISION

Production operations are divided among four metallurgists, who change departments every two years and are in charge of the plant on alternate weekends; that is, one weekend in every four.

The areas of responsibility of the respective metallurgists are 1) incoming material, sampling, and the laboratory; 2) preparation of sinter and the sinter plant; 3) blast furnace, dross, and dross smelting; and 4) bag houses and Cottrell. The metallurgists are responsible to the superintendent for the various departments.

The safety program at the plant is the responsibility of the assistant superintendent and the safety department, who in turn are responsible to the manager. The engineering department is under the plant engineer, who is responsible to the superintendent.

As most of the metallurgical functions have been previously mentioned, some mention should be made of the engineering and safety departments.

ENGINEERING OFFICE

The engineering department is responsible for maintenance of the plant's production facilities. As the smelter is old, and many changes have been, and are being made, the engineering department has played an

important part. While much of the designing of equipment, i.e., the new blast furnace and dust bins, has been done by the company's Western Engineering office in Salt Lake City, the installation of these changes has been the responsibility of the East Helena smelter. The design and construction of the continuous tapping features, and the disc pelletizer was also done at East Helena.

Simplified drawing techniques are also being experimented with at East Helena, and if they prove successful at the plant, it is probable that all plants, as well as the larger engineering offices of the company, will adopt these simplified drawing practices.

SAFETY PROGRAM

A noteworthy achievement at the East Helena plant has been the safety record, which extended for more than four years without a lost-time accident. Considerably more than 2,500,000 man hours were completed before this record was broken by two lost-time accidents in 1957. This safety record is evidence of the efficiency of the plant's extensive safety program.

A paper, written by Mr. E. A. Hase, assistant superintendent at the East Helena plant, was presented to the AIME convention in Portland, Oregon in April, 1957. The following details of the safety program were taken from Mr. Hase's paper.

Management in East Helena feels that safety is necessary to efficient operation; therefore, it must be given top priority at all times. When a new man is hired, he is indoctrinated by a safety inspector and given books on general plant safety rules and departmental safety rules, applicable to the department to which he has been assigned. The plant consists of

eight departments, each with its own set of safety rules. In addition to the set of rules, the new worker is also given an on-the-job safety talk by his foreman.

There are several committees on safety which meet at regular intervals, as illustrated in Fig. 7. The employees' safety committee meets twice each month, and consists of one man from each department plus a safety inspector. Suggestions which have been turned down or are inactive, may be brought up again by a joint safety committee. This committee consists of two men appointed by the Union who meet once a month with the assistant superintendent and safety inspector.

In addition to the employee meetings, there are weekly plant inspections by a committee consisting of one department head, one foreman, one workman, and a safety inspector. Committee membership rotates each month after a complete plant inspection has been made. All department heads meet with the superintendent once each week. Plant inspections are discussed and acted upon, as well as suggestions from employee and joint safety meetings. Once each month, a general foreman safety meeting is held; suggestions are discussed; investigations and recommendations on serious non-disabling accidents are read; and new policies and programs are introduced.

Up-to-date safety equipment is used throughout the plant. The wearing of hard hats and safety spectacles is mandatory for everyone. Safety prescription lenses are furnished to everyone who wears glasses. Respirators, both fume and dust, are furnished where and when needed. A cleaning station attendant keeps respirators clean daily. Each department has a cleaning station for safety spectacles. The use of safety shoes is encouraged, and, as a result, they are worn by practically everyone. In

addition, chrome leather chaps, aprons, sleevelets, face shields, coveralls, foot guards, safety tow rubber boots, rubber gloves, and raincoats are issued whenever a job requires them.

Safety slogans, messages, and posters are displayed on bulletin boards and blackboards throughout the plant. A large accident record panel is maintained at the plant entrance to show departmental standing and the number of days since the last disabling accident. Several periodicals and booklets on safety are distributed regularly to department heads and foremen. In the spring of each year, the safety inspector, who is a qualified Red Cross first aid instructor, holds classes in first aid for the employees, and at present, over 80 per cent of the employees have at least one Red Cross first aid certificate.

The plant at East Helena participates in company-wide safety meetings and competes in the company-wide organization for the best frequency and severity rates. This competition has been won for the past four years by the East Helena plant with a frequency and severity rate of zero.

EAST HELENA PLANT SAFETY ORGANIZATION

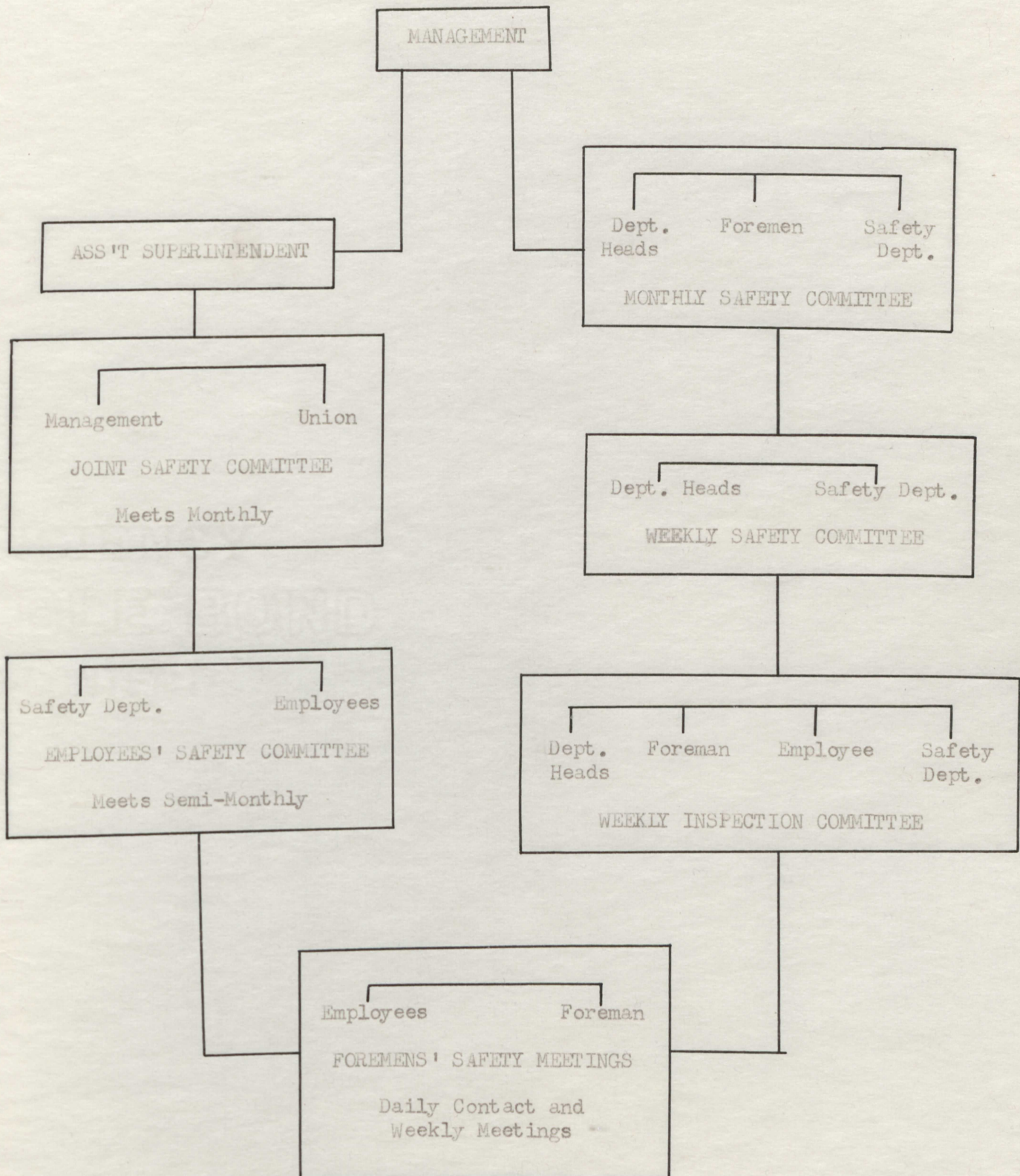


Fig. 8

CONCLUSION

The East Helena smelter, although a relatively old plant, has been surprisingly progressive. It has earned a reputation for its productive efficiency, which is due principally to aggressive management and a desire to do the job better and more economically. Results of the continued efforts of the plant management are well illustrated by the plant's safety record, as well as by the improved production methods developed.